

UNPUBLISHED PRELIMINARY DATA

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Attention: Dr. T.L.K. Smull, Director

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This the 6th quarterly status report on Contract No. NASr-54(03), covering the period May 1, 1964 to July 31, 1964.

The project effort during this quarter was divided among the following tasks.

1. Laboratory Testing of Radiation Measuring Instruments
2. Analysis of Data Obtained on Previous Balloon Flights.
3. Design and Construction of Equipment for the Next Balloon Flight
4. Analytical Study of Atmospheric Radiation Processes
5. Development of an Infrared Interferometer for Spacecraft Use

The interferometer development has received the major portion of the effort of the laboratory. The study of stellar refraction as a meteorological satellite technique is now being funded separately from this contract and is therefore no longer reported on under this contract.

1. Laboratory Testing of Radiation Measuring Instruments

Additional calibrations of the NIMBUS MRIR radiometer were made with the hemispherical cavity radiation source.

Other laboratory tests included measurements of the reflectivity and transmissivity of styrofoam material which is used for insulation and as a reflector for solar radiation on the high altitude balloon flights.

2. Analysis of Data Obtained on Previous Balloon Flights

The analysis of the 26 June, 1963 balloon flight data continued.

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The processing of NIMBUS MRIR channel IV data was completed.

Some TIROS radiometer channel I and channel IV data has been processed, but is unsatisfactory since the calibrations are still in doubt.

A small amount of the aircraft flight test data have been processed. Instrument temperatures for flight 8006 have been obtained.

3. Design and Construction of Equipment for the Next Balloon Flight

On the next balloon flight, it will be necessary to control the operating temperatures of each of the radiation instruments used. Since it appears that the desired operating temperatures will not be the same for each instrument, this temperature control problem may be a difficult one to solve.

In order to obtain some data which can be applied to the thermal design of the next balloon gondola, an environmental test was run on thermal models of three of the instruments which will be flown, the SIRS and JPL spectrometers and The University of Michigan infrared interferometer. This environmental test was run in June.

The construction of the new balloon gondola and of the electrical control equipment to be used on the next balloon flight was completed in June, and this equipment was prepared for a second environmental test to check the thermal control system which has been designed by the Weather Bureau for the SIRS spectrometer.

Most of the new ground station equipment needed for the next balloon flight has been received. All of the new discriminators have now been received as was the Ampex CP-100 tape recorder which has been loaned to us by JPL.

The airborne telemetry chassis is not yet complete. Twenty used EMR model 171 VCO's were received and tests are now being made to see if they can be modified to meet our requirements.

4. Analytical Study of Atmospheric Radiation Processes

The analytical study of atmospheric radiation processes continued.

First, an efficient technique suitable for use as a computer subroutine has been developed for the calculation of an absorption coefficient when both Doppler and collision broadening must be considered. A note describing this technique has been submitted for publication in the Journal of Quantitative Spectroscopy and Radiative Transfer.

Secondly, work has continued on the calculation of transmissivities for atmospheric slant paths in the 15 micron CO₂ band. A method for the elimination of the Curtis-Godson approximation has been developed for Lorentz and mixed Doppler-Lorentz broadening. A subroutine for the evaluation of the resulting integral was written.

5. Development of an Intrared Interferometer for Spacecraft Use

The development of the infrared interferometer proceeded at a very rapid rate during this work period. The operation of the first mirror drive system was demonstrated in June 2, a second improved mirror drive system was delivered to Goddard Space Flight Center on July 7, and an operating breadboard interferometer was demonstrated on July 23. The mirror drive system on this breadboard was operated open loop and thus successfully demonstrated only the mechanical portion of the mirror drive system.

This instrument did not meet the desired specifications in the following respects:

- a. The resolution was about 9 cm⁻¹ instead of the 5 cm⁻¹ desired.
- b. The I.R. signal to noise ratio was about 250:1 instead of the necessary 1500:1.
- c. The 5852 Å° signal for monitoring the mirror drive and controlling the data sampling had an amplitude of 10 microvolts instead of the 1 millivolt desired.

The inferior resolution indicated above was due to the tilting of the mirror on its spring mounting for displacements greater than 1.5 mm. An extensive effort aimed at the development of a more satisfactory spring system has been started.

It appears that the beam splitter is the portion of the instrument which is the limiting factor for both the I-R and 5852 Å° signals. The 1/4 inch KBr beam splitter used was flat to within about 4 microns and had a germanium coating applied on the basis of empirical tests made in our laboratory. It is felt that a considerable improvement in signal can be obtained with an improved beam splitter. An extensive effort will be made to improve the beam splitter design. Thicker KBr plates which can be made with improved flatness will be used, and methods of improving the germanium coating will be pursued.

The status of the development work on the various components and processes which go into the making of a completed interferometer are as follows.

The status of the beam splitter is given above. The spectral reflectance of a series of KBr and Irtran IV plates with germanium coatings of various thickness has been studied to obtain design data for the beam splitter. Anti-reflection coatings have also been studied.

The detector module used on the scientific breadboard consisted of a KBr lens and a germanium immersed detector. An improvement in signal to noise ratio for the I-R signal is expected from a new detector module which is being developed. This detector module will use a reflective light cone (which is to be made by O.C.L.I.) an Estman Kodak KRS-5 lens and a Barnes thermister detector. It will be assembled here at The University of Michigan.

Pre-amplifiers have been ordered from both Barnes and the Ithaco Co. Noise figure measurements made here indicate that they are equally good. Twelve Ithaco amplifiers have been ordered for future use.

Interferometer data processing activity includes the digitizing and calculation of spectra from simulated interferograms. The digitizing was done on equipment available in the Department of Meteorology.

Although the interferometer has not yet been developed to the point where accurate calibrations are necessary, the calibration process has been considered and equipment has been ordered.

The mechanical portion of several mirror drive systems have been built and tested and, as noted above, additional work must be done on this problem.

The electronic circuitry necessary to have a "closed loop" servomechanism mirror drive system was also under development during this period. A switching mode power amplifier and a stable high-speed high input impedance operational amplifier circuit were developed. A scheme for comparing the tuning fork clock signal with the 5852A° interferometer signal and for generating an error signal to use in the servo-drive was considered and then abandoned in favor of a position control scheme using a differential transformer as a position sensing device. A mirror drive servo loop incorporating this differential transformer scheme was constructed and tested.

6. Report Writing

Two sections of a report on the interferometer spectrometer were written. The report will be written at Goddard Space Flight Center and the parts of the sections written here will be incorporated into the Goddard report.